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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 28.

B. T. GALLOWAY, Chief of Bureau.

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THE MANGO IN PORTO RICO.

BY

G. N. COLLINS,

Assistant Botanist in Tropical Agriculture,

Botanical Investigations and Experiments.

Issued January 17, 1903.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

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THE MANGO IN PORTO RICO.

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G. N. COLLINS,

ASSISTANT BOTANIST IN TROPICAL AGRICULTURE,

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., September 27, 1902.

Sir: I have the honor to transmit herewith a paper on The Mango in Porto Rico, by G. N. Collins, Assistant Botanist in Tropical Agriculture, and respectfully recommend that it be published as Bulletin No. 28 of the series of this Bureau. The paper has been submitted for publication by the Acting Botanist in Charge of Botanical Investigations and Experiments.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

The mango is a fruit highly esteemed throughout the Tropics, in most places outranking in popularity both the banana and the orange. European residents in the Tropics almost universally acquire a fondness for the mango, and in England the demand for it is steadily increasing, it having been found possible to make importations from India, notwithstanding the immense distance. The mango is as yet little known in the United States, having been represented in our markets only by fruit of inferior varieties. These give no suggestion of the qualities of the better sorts and tend rather to discourage than to increase the demand. If an effort similar to that which brought the banana into favor in the United States could place an adequate supply of good mangoes before the public, there is no apparent reason why this new tropical fruit should not repeat the history of its now popular predecessor.

Porto Rico is favorably located for the growth of the mango, the south side of the island especially possessing the right climatic conditions. The trees are very prolific and remarkably free from diseases. High-grade varieties are already growing in different parts of the West Indies, Florida, Central America, and Mexico, and their introduction into Porto Rico should be attended with little difficulty.

This bulletin, written by Mr. G. N. Collins, under the direction of Mr. O. F. Cook, botanist in charge of investigations in tropical agriculture, and based largely upon observations made by the author while engaged in a botanical exploration in Porto Rico in cooperation with the recently established Porto Rico Agricultural Experiment Station, discusses the possibilities and requirements of the mango there, and it is hoped that it will help to establish the growing of mangoes as one of the profitable industries of the island.

LYSTER H. DEWEY,
Acting Botanist.

OFFICE OF BOTANICAL INVESTIGATIONS AND EXPERIMENTS.
Washington, D. C., September 18, 1902.

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THE MANGO IN PORTO RICO.

INTRODUCTION.

The mango is considered by many to be the finest of tropical fruits, though on this point there is much diversity of opinion, occasioned to a great extent by difference in taste, but still more by the great diversity in the fruit itself, which varies enormously in different localities, there being large areas where the mango is common and where not a single good variety is to be had. Persons forming their opinion of the fruit in such localities usually indorse the proverbial statement that the mango is "a mass of tow saturated with turpentine." On the other hand, those acquainted with the fruit at its best are almost unanimously enthusiastic in their praise. Elphinstone, the historian of India, says:

> The mango is the best fruit of India, at once rich and delicate, and all other fruits are comparatively insipid beside its intensity of taste. There is something in it that is nothing less than voluptuous.

A taste for mangoes, at least for the varieties existing in Porto Rico, has in most people to be cultivated; but once acquired, it is like a taste for olives, and becomes almost a craving. The milder flavored varieties, in which no taste of turpentine is to be detected, are usually enjoyed even by the novice, but after one becomes familiar with the fruit a slight taste of turpentine ceases to be disagreeable. The fiber, however, that exists in the poorer varieties is an unmitigated evil, and renders the eating of a mango a serious operation, to which one must devote his entire attention and may need to conclude with a bath. In the varieties where the fiber is the worst, one can not even have recourse to slicing the meat from the seed, as in that case the cut ends of the fibers are stiff enough to irritate the tongue.

Good mangoes are produced in America, but as yet in such small quantity that few persons have had an opportunity to taste any but inferior fruit. Sample lots of the more common and poorer varieties are frequently shipped to northern markets, and have doubtless done much to hinder the growth of the trade. A first impression is very lasting, and first impressions of the mango based on such fruit are likely to be anything but favorable. As an example, mangoes are frequently

to be found in the Washington market, but we have never seen one that could be called good, even in comparison with the Porto Rican fruit.

This impression formed in the minds of the novelty-loving public will doubtless be difficult to dispel; but if really good mangoes could be placed in the markets their increase in popular favor would be certain and the growing of mangoes might become a profitable pursuit.

In spite of the fact that in all mango-producing countries the natives consider the fruit wholesome and perfectly safe, prejudice against it exists among some military officials and others, who condemn the fruit as positively dangerous. During the Spanish war this prejudice was so strong that the soldiers in Porto Rico were prohibited from eating the mango, and many beautiful trees were cut down. This unjust prejudice probably arose from eating the fruit when unripe, in which state, like most other fruits, it is unwholesome. Soldiers, hungry for fresh fruit and quite unfamiliar with the mango, might easily mistake the green for the ripe, especially as in Porto Rico some of the varieties when ripe still remain green in color. All varieties become mellow when ripe, however, and if eaten in that condition can not but be wholesome. It is commonly believed in Porto Rico that the mango and rum should never be partaken at the same time. This again probably applies to the green fruit.

In some parts of India the natives at one season of the year live almost exclusively on mangoes, apparently without harm; and among the writers consulted all commend it as extremely wholesome except Sir George Birdwood, who states that the fruit is apt to act injuriously on the kidneys. On the other hand, the mango is considered by most authorities to have medicinal properties decidedly beneficial. An extract from the Pharmacographia Indica, in Watt's Dictionary, describes the fruit as "invigorating and refreshing, fattening, and slightly laxative and diuretic."

DESCRIPTION.

The mango tree (*Mangifera indica*) varies in height, according to the variety, from little more than a bush to a tree 50 to 70 feet high, with a trunk 6 to 10 feet high and 2 feet or more in diameter. The leaves are lanceolate, about 1 foot in length, tapering gradually to a narrow point, with a smooth, shining surface. The young leaves are first pink, then red before turning green. The top is rounded and very dense. (See Pls. I, II, III.) The bark is gray and smooth. The flowers are small, reddish-white, or yellowish, borne in large upright racemes. The fruit varies greatly, according to the variety. In some kinds it is not more than 2 or 3 inches in greatest diameter, while others are three or four times that size, some weighing as much as 4 pounds. In form they vary from nearly spherical to long and

narrow like a cucumber, straight or crooked. The most common varieties are usually from 2 to 4 inches in length, more or less kidney-shaped, with the "nak," or stigmatic point, more or less produced. In color they may be green, yellow, or red. In composition the difference is no less pronounced. In some the seed is large (see Pl. IV, fig 2), and the thin flesh between it and the skin consists almost entirely of fiber attached to the seed, while in others the seed is small, and in some so nearly aborted that it is easily cut with a knife. In the best varieties the fiber is almost entirely wanting and the entire fruit consists of a mass of juicy, usually orange-colored pulp. This in some varieties is so firm that it may be sliced with a knife; in others it is soft enough to be eaten with a spoon.

The characters usually utilized in distinguishing varieties of the fruit are the size, color, and form; the extent of the depression at the stem; the location and prominence of the "nak" or stigmatic point; the color and thickness of the flesh and the amount of fiber contained; the presence or absence of a turpentine flavor. The seeds of different varieties are also very distinct. A glance at Pl. V will give some idea of the diversity, and although these characters are quite as constant as those more commonly used, they seem never to have been utilized in the description of varieties.

The Anacardiaceae, to which the mango belongs, include also the turpentine tree (*Pistacia terebinthus*), the original source of turpentine, and it seems not at all unlikely that the characteristic odor of the mango is in reality due to the presence of turpentine or some closely allied substance. Exudations of a transparent resinous substance similar to that of the turpentine tree are frequently to be noticed in the mango.

ORIGIN.

The mango (*Mangifera indica*) is said by De Candolle to be native in South Asia or the Malay Archipelago, and recent authors report it as wild in the forests of Ceylon and the regions at the base of the Himalayas, especially toward the east, at an altitude of from 1,000 to 2,000 feet. The species has been so long under cultivation that it would be extremely difficult to locate definitely the place or places where it was actually domesticated. The general region is, however, without doubt that given above. Of the 37 species of Mangifera enumerated in Index Kewensis, all are from the Indo-Malayan region except two—one, described by Oliver, from West Africa, and one, by M. Dessousseaux, from the island of Mauritius. Engler and Prantl describe the genus as containing 27 species from the East Indies and the Malay Archipelago. Its culture is very ancient, as shown by references in Sanskrit mythology and ancient Hindu folklore.

For so old and so useful a plant, its distribution was comparatively

limited until historic times. To the west, it had not passed the Red Sea, being unknown in Egypt, while to the east it had apparently not reached the islands of the Pacific. According to Rumphius (1750) it was introduced into some of the islands of the Malay Archipelago within the memory of living men, though the variety of native names would argue an earlier introduction. The species is not well adapted for distribution by natural agencies, and man has probably been chiefly responsible for its dissemination.

In the New World it seems to have been first introduced into Brazil, although it is not known at what date. The earliest record of its introduction into the West Indies appears in Hughes's Natural History of Barbados, 1750, where it states: "This tree or its seed was recently brought from Rio Janiero and grows only at the Guiney plantation." The date of this importation is more definitely placed at about 1742 or 1743 by letters published in Transactions of the Society for the Encouragement of Arts, etc., 1786, page 217. In 1782 Captain Marshall, of Lord Rodney's squadron, captured a French vessel, bound from the island of Réunion or Mauritius to Santo Domingo, that had on board many valuable plants, among which was the mango, said to have been in the form of grafted stock. These were planted in the botanic gardens of Mr. Hinton East at Gordon Town, Jamaica. Two kinds—one labeled No. 11 and the other No. 32—have since been known by these designations, No. 11 being one of the most popular varieties in Jamaica at the present time.

The mango is now a common fruit throughout the Tropics of the world. It has been developed to the highest state of perfection in its home in India, where the number of well-marked varieties is enormous. Mr. Maries, of Durbhungah, has collected over 500 varieties, 100 of which he characterizes as good. Thirty-four of these varieties he describes in Watt's Dictionary of Economic Products of India. Ceylon is also famous for its mangoes. Both the east and the west coasts of Africa have several good varieties. In Australia the culture is fast increasing, and it bids fair to become one of the most popular fruits. One very fine variety is said to exist in the island of St. Helena. The mango is the most highly prized fruit of Guam, where there is a fine seedling variety. Its cultivation in that island is, however, not a success, owing probably to the thin soil, which affords such a shallow footing that the hurricanes uproot the trees in all exposed localities. In the Hawaiian Islands, Mr. William C. Stubbs[a] reports: "The mango is receiving perhaps more attention just now than any other fruit. As many as twelve or fifteen varieties have already been introduced. It is a delicious fruit, and decidedly ornamental in any ground." In the New World, Trinidad and Jamaica

[a] Bul. No. 95, Office of Experiment Stations, U. S. Dept. of Agriculture, Report on the Agricultural Resources and Capabilities of Hawaii, p. 40.

have the largest collections, although the drier regions of Central America and Mexico may be found to offer better seedling varieties.

In spite of the many discouraging frosts that have visited Florida, planters of that State are actively engaged in propagating good varieties by budding, grafting, and inarching, and, if visited with no further misfortune, will in a few years produce considerable quantities of high-grade fruit.

CULTURE.

REQUIREMENTS.

The mango will grow in a variety of conditions, and it seems to have little preference as to soil, the most important requirement being a deep soil that is well drained. As to climate, it is much more exacting, and the fact that the tree may thrive well in a given locality and yet fail to produce fruit should be kept always in mind. It may be considered as proven that the mango will be prolific only in regions subjected to a considerable dry season. On the moist north side of Porto Rico the trees grow luxuriantly, but they are not nearly so prolific nor is the fruit of such good quality as on the dry south side, and in the very dry region about Yauco and at Cabo Rojo the fruit seemed at its best, while its abundance was attested by the fact that fine fruit was selling as low as 12 for a cent. In Guatemala and Mexico the mango was found at its best only in regions where severe dry seasons prevailed. This position is amply supported by reports of the mango in other localities.

The moist conditions that prevail at the Botanic Gardens of Trinidad are reported by Mr. Hart[a] to be very unfavorable to the production of mangoes, a decided improvement being noticed in particularly dry seasons. This was also found to be the case in Jamaica, reports from different parts of the island[b] all agreeing that the mango fruits but sparingly in moist localities, and in such is much more prolific in dry seasons.

Rains at the time of flowering seem to be especially injurious. It has been suggested by Mr. Hart and others that the moist weather interferes with pollination. If this is accomplished by insects the damp weather may easily affect their operations. Information on this point seems entirely wanting and investigation might be well repaid. In cases where the trees do not flower the explanation is probably to be found in the fact that the mango, like so many other plants, needs some check to its growth to induce the formation of blossoms. Where the dry season is lacking, artificial means of checking the growth are often resorted to, and old trees that have never borne fruit are sometimes made to produce enormous crops.

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[a] Bul. Royal Bot. Gardens, Trinidad, July, 1899, Vol. III, pp. 190–194.

[b] Jamaica Bul., November and December, 1901, Vol. VIII, pp. 161–178.

The tree is seldom seen at high altitudes, but this may also be due to the fact that high altitudes are often moist. At Senahu, Alta Vera Paz, Guatemala, trees were seen growing at an altitude of between 2,000 and 3,000 feet. They looked strong and healthy but were without signs of fruit or flowers, and it was said that these trees had never been known to produce fruit.

METHODS OF PROPAGATION.

SEED.

The mango grows readily from seed, and this is the only method of propagation practiced in Porto Rico. For transporting the seed long distances it is, of course, necessary to remove the pulp, and the best results have been obtained with cleaned seeds, dried on the outside and packed so as to conserve the moisture without molding. Packed in this way, several successful importations of seed have been made from the East Indies to Florida.

The ease and rapidity with which mangoes can be propagated by means of seed are decided advantages, but the results are very uncertain, and very few of the really desirable varieties can be maintained by this method. There are a few good varieties in different parts of the world the seedlings of which appear to produce fruit identical with the parent.

Much could doubtless be done to improve the mango in Porto Rico by the growth of seedlings from selected fruit, and really good varieties might be originated. Cross fertilization of the flowers might produce new varieties and increase the chances of producing good forms. On the other hand, if the mango follows the analogy of other fruits, it might be worth while to try the experiment of self-pollinating some of the best varieties, with the idea that the reproductive fertility would be thus impaired and the size of the seed reduced.

A more expeditious method of reducing the size of the seed might be to cross-fertilize with the pollen of some variety or perhaps species so distantly related that partially or completely sterile hybrids would be secured. Breeding experiments of all kinds require, however, so much time that for practical purposes the introduction of superior varieties existing in other countries is certainly the first step to be taken.

INARCHING.

This, and methods to be described later, provide means of propagating good varieties, so that the fruit of the new plant will be identical, or nearly so, with that of the parent. No greater variation need be expected than that occurring on a single tree.

In India and wherever the cultivation of the mango is carried on to any great extent, inarching is by far the most common method of

propagating. An article in the Sugar Journal and Tropical Cultivator describes the process as follows:

The best method of propagating good varieties of mangoes is by means of inarching, which is a very simple process. It is performed usually between a large tree of superior variety growing in the ground and a seedling growing in a pot—small, cheap flowerpots about 8 or 9 inches deep and 6 inches diameter do well for the purpose. The soil should be good potting soil, with a fair proportion of manure. A single large mango stone should be planted in each pot. The seedlings are ready for inarching, if well grown, in ten months or so; if not well grown, they should be older. Two-year-old seedlings are very successfully inarched. The stem of the seedling should in each be fairly thick, with the wood fairly developed—near the root the stem will be somewhat thicker than an ordinary workingman's smallest finger. Any number of seedlings in pots can be inarched in one tree by erecting a stage [for their support] under the lower branches. The stem of the branch to be inarched should be about the same thickness as the stem of the seedling, and like the seedling, should be fairly developed wood. The juncture where the inarching is performed should be about 6 or 8 inches from the root of the seedling and about a foot or so from the growing point of the branch, unless the branch is making new vigorous growth, in which case the distance will be more. A straight, well-shaped branch should be selected, so that the future grafted tree will be well proportioned. A slice of wood and bark should be cut from the seedlings and from the branch, so that the inner bark of both can be made to touch accurately; the two wounded surfaces are bound securely with tape or bast fiber, and grafting clay applied to keep out air. The juncture of branch and seedling should extend for a length of about 3 inches, but at no point should the wound in either be deep; the slices should in fact be of almost uniform thickness throughout and not thick. Tenaceous clay should not be used to cover the inarch; it soon cracks and admits air. One part of fresh cattle dung, mixed with two parts of good soil, kneaded together with a little water, serves the purpose excellently. Inarching can be done in India at any season, but it is most successful when the trees are in active growth. It takes some time (several months) before the inarched juncture is perfectly joined by the new wood and bark cells. Meantime the seedlings in the pots must be carefully and regularly watered. When the juncture is complete the leading shoot of the seedling should be removed immediately above the inarch juncture and some days afterwards the branch of the tree may be severed immediately below the juncture.

Trees for inarching should be in a sheltered situation, because if swayed much by the wind the pots or the platform are disturbed from their position.

In planting out young grafts the pots should be broken if the young plant can not be removed without disturbing the earth on the roots. If the earth on the roots is much disturbed the plant will almost certainly die. They should be planted with plenty of manure in pits 3 feet deep and wide.[a]

Mr. Lewis A. Bernay, in "Cultural Industries for Queensland," recommends that the seedlings be inarched when only three weeks old and 6 or 8 inches high. They can then be taken from the pots, the roots wrapped in grass, and the whole tied to the branch which is to be grafted. He recommends that the grafting be done early in the rainy season, and states that the grafts may be severed from the parent within a month or as soon as thirteen days. Inarched mangoes should come into bearing in from three to five years after planting.

[a] The Journal of the Jamaica Agricultural Society, May, 1898, pp. 168, 169.

Inarched stock in Wardian cases can be shipped long distances, and importations into Florida have shown that if properly handled a fair percentage of the plants may be expected to live.

Other forms of grafting are also used to some extent to propagate mangoes. Grafting is, however, difficult in the case of the mango, and can only be practiced by experienced hands.

LAYERING.

Propagation by layering, a method used to some extent where early fruiting trees are desired, is described in Firminger's Manual of Gardening (p. 86), as follows:

Select a branch of ripened wood of the plant to be layered that will bear being bent down to the earth without breaking. Cut the branch half through with a sharp knife just under one of the leaf buds toward its extremity, and then pass the knife upward, so as to slit the branch about an inch or two up. The slit piece, with the leaf bud at its extremity, called the "tongue," should be kept open by inserting a small piece of tile. Remove the earth to the depth of 2 or 3 inches from, or place a flowerpot over, the spot just where the tongue falls on the branch being bent down; then carefully bend the tongued part of the branch into the earth or into the flower pot, secure it in that position by a peg, and cover it over with earth, which should be pressed down and watered.

Chinese layering, a variation of this method, called gootee in India, where it is used to some extent, is described by Mr. Masters[a] of the Calcutta Botanical Gardens as follows:

Select a firm, healthy branch, the wood of which is well ripened, and immediately under a leaf bud take off a small ring of bark about 1 inch wide. Scrape the woody part well, so that no bark remains. Apply a ball of well-tempered clay; bind it on securely with a tow or other soft bandage; make it fast to a stake if necessary; hang a small pot, having a hole in the bottom, just over the gootee and supply it with water daily. In a few months you obtain a fine, well-rooted plant.

As the fibers are emitted from the buds that are above the wound they will descend into the ball of earth and form roots. As soon as they are seen protruding themselves through the bandage, the branch may be cut off from the parent tree, and planted where it is intended it should remain. This appears to be the most expeditious method of obtaining strong, well-rooted plants, and, at the same time, is a sure method of procuring duplicates of any desirable variety.

An ingenious method for watering the gootee is described by Firminger, as follows:

A piece of rope has a knot tied at one end of it, the other end is passed within the pot and drawn through the hole at its bottom until the knot is brought down to fall upon and close up the hole. The rope, thus secured by its knotted end within the pot, is carried on at full stretch and coiled around the gootee. By this means the water, when poured into the pot, oozes slowly out, trickles down the rope and along the coil, and so distributes itself along the whole gootee.

Trees started by layering or gootee are said to be prolific, but to bear small fruit. They are also thought to be short lived. These objections are so great that these methods are seldom employed.

[a] Firminger's Manual of Gardening, pp. 87, 88.

PATCH BUDDING.

The budding of mangoes was formerly thought to be extremely difficult, but planters in Florida have found it one of the best methods of propagation, and use it very extensively on stocks that are to remain in place. For nursery stock that is to be transplanted inarching is still considered the most satisfactory. Budding has lately been tried in India, but has not as yet proved successful.

What appears to be an entirely new method of budding is described by Mr. Knight in the Queensland Agricultural Journal for July–September, 1900 (p. 256), under the name of bark grafting. If all that is claimed for it is true, it would seem to put an entirely new aspect on the propagation of improved varieties, making transportation of scions an easy matter and their propagation so simple and sure that it can be undertaken by persons having no special training or experience. The possibilities are at least sufficient to warrant thorough experiments. Mr. Knight says:

After twelve years' close observation and a large number of experiments made on the mango tree, the conclusion that I have arrived at is that no tree is simpler to graft.

The work can be successfully done by anyone and at any time, whether the sap is active or dormant. The buds are certainly not so quick in coming when the sap is down, but they make up for any delay when once started.

Still it can not be said that grafting, when the sap is down, is the best time for the operation. On the contrary, the first three months in the year have proved to be preferable. All the remarks in this article apply to one process only; that is, the use of bark without any wood adhering to it. Up to date the best material for tying on the grafts is ordinary candle cotton, procurable at the ironmongers, and generally sold in 1-pound balls. The grafts are simple pieces or bark without any growth whatever on them. Of course there must be dormant buds or eyes on them. The pieces of bark may vary in length and width according to the size of trunk or limb on which they are intended to be engrafted.

The plates accompanying this article show grafts measuring 2¼ inches long by five-sevenths of an inch wide for the smallest piece, and 3¼ inches by 1¾ inches wide for the largest size. Mr. Knight further states:

The most convenient size to use is a piece about twice the length of the width, and if taken off where rings exist, so that the ring is across the center of the section, there will be two or three latent buds near the ring. The rings on the trunk and limbs denote the exact number of growths and rests the tree has made. At the point of every new growth, while resting, there is a whorl of leaves and at the base of every leaf there is a bud which is capable of becoming a tree, and whether it is used for grafting during its infancy or ten years afterwards it will develop with proper treatment. The youngest bark used on the tree shown on Pl. 11 (1) was 4 years old and the oldest section 9 years old when transplanted. The older the bark the easier it is to remove, and it is much handier to trim into shape. First cut out the section for transplanting, and, should the edges be bruised and torn, cut them away to sound bark. Now press the piece firmly onto the spot where it is intended to grow and make a clean cut all round. Next take out the bark inside the mark and put the prepared section in its place. Do not make it fit so tightly that it has to be

squeezed in, but make it a nice fit. Now bind it with the candle cotton, with just sufficient pressure to make it touch its new parent. Avoid, if possible, binding immediately over the buds. The old notion that all air must be excluded to effect a union is a delusion as far as grafting the mango is concerned. There is no necessity for clay, grafting wax, or any other nasty stuff to insure a good union, but just the candle cotton. Now it may be that a section of bark has been prepared for transplanting which is much thicker than the piece taken out. Well, never mind; tie it on, and it will grow, although it is not a comfortable fit. Should the weather be hot and dry when the grafting is being done the top may be left on the tree for shade, but it must be thoroughly ring-barked 6 or 8 inches above the graft. In two or three weeks cut the top off at the spot where it was ring-barked, and if the buds on the graft have started into growth remove the binding.

When the young shoots which have sprung from the grafts have ripened, the old wood projecting beyond the graft should be sawn off close to the base of the new growth. As the new wood continues to grow it will cover up the entire end where it was sawn off, making very neat work of it. In the mango a term "ripened" shoot applies when the leaves and bark of the latter have taken their full green color (chlorophyll), or when the shoot has rested and is ready to continue its growth.

In a matured growth, the green coloring matter has been succeeded by a brown color which varies considerably with age.

Accompanying the above article were photographs showing: (1) A tree with its entire top cut off and fourteen different varieties of mango grafted on it, all of which were growing; in less than two months from the time of grafting the new growth in some cases measured 7 inches. (2) A grafted mango tree where the grafts had made a growth of 3 feet 6 inches in twelve months, with no cultivation. Mr. Knight adds that experiments have proven beyond a doubt that "sections of the mango tree will keep good for grafting purposes from three to six months' time according to variety and the constitution of the tree from which they are obtained." Such mature bark with its dormant buds would probably be much less subject to injury and decay during the vicissitudes of the voyage to the West Indies than would the tender shoots usually employed as cuttings, and as no such time as the above is necessary for the journey from India to the West Indies, it would seem that the introduction of the best varieties into Porto Rico might now be a comparatively simple matter.

Mr. G. W. Oliver,[a] of the United States Department of Agriculture, has recently reported excellent results with a method called by the preferable name "patch budding," similar to that described by Mr. Knight, but originated independently. Mr. Oliver's directions are as follows:

The method I wish to call attention to must be performed under certain conditions, the first and most important of which is that the stock must be in active growth. The best time is when the new leaves are not far enough developed to show the bright green color. The bark is then most easily removed. Choose the thick part of the stem only a few inches above the surface of the ground; cut out a rectangular

[a] "The Propagation of the Mango," in The Florists' Exchange, New York, Apr. 19, 1902, p. 461.

piece of bark about 1½ inches in length, and from the variety to be propagated cut a similar piece with a bud in the center, not, however, from new wood, but from that which is at least 2 years old and which has lost its green color and assumed the grayish brown tint. Fit the section of bark, with bud attached, into the space formed by the removal of the bark from the stock. If this piece of bark removed from the stock has a bud in the central part, the wood exposed to view will fit better with the section of bark to be applied. When the section has been put in place, with a small brush apply a light coating of liquid grafting wax in which there is a large quantity of resin, to the cut parts, and immediately tie firmly with thick pieces of raffia; then an 8-inch wide strip of strong wrapping paper wound round and round the stem a few inches above the bud, and tied above with a cord, completes the operation for the time being.

If good material is selected and the operation carefully carried out at the proper time, there is no reason why a high percentage of successful unions should not be secured.

It is said that in Martinique[a] the mango has been successfully grafted on the cashew tree (*Anacardium occidentale*), and it is further stated that seedling mangoes so grafted produce fruit doubled in size, free from fiber, and with the seed so reduced that it is frequently without the power to germinate. The fruit although melting and very juicy is said to be without flavor. These results, as reported, are so radically opposed to those usually obtained from similar experiments that they are not likely to be generally accepted until verified.

CULTIVATION.

The culture of the mango in localities to which it is suited is largely a question of the best method of propagation. Once established the tree needs little care.

Whether mangoes are planted directly in the field or started in pots and transplanted, it is recommended that the holes be prepared some time in advance, and, if possible, that a layer of rich soil, mixed with bones, be placed at the bottom. Manuring in the early stages, though often retarding the production of fruit, makes strong, vigorous trees. Twenty to 30 feet is recommended as a good planting distance, though this should doubtless be modified according to the variety, as some kinds produce much larger trees than others. For the varieties already in Porto Rico this distance should probably be increased to 40 or 50 feet. The better grafted varieties usually make much smaller trees, and with these the distance might be reduced to 15 feet or even less. If subsequent manuring is practiced, the fertilizer should be applied after the fruiting season, and at the same time the ground around the trees should be stirred.

In parts of India the young trees are shaded for a time until they are large enough to stand the sun, and bananas are recommended to provide the desired protection. In Porto Rico this seems hardly

[a] Annals de la Societe d'Agriculture de la Martinique (Tome II), quoted in Jumelle's Cultures Coloniales, p. 212.

necessary, except perhaps in some of the very dry localities on the south side.

In moist regions, where the mango fails to flower, it will be found necessary to check the growth. This can be accomplished in a variety of ways, the most primitive of which is mutilation of the trees or ringbarking the smaller branches. This method is common in India, but is not recommended as it disfigures the trees and may eventually kill them. Concerning the efficacy of this treatment, Mr. Horace Knight reports that in Queensland trees 10 or 12 years old that had been bearing only about a dozen fruits, after being ringbarked on their smaller branches by opossums, bore such a crop that they had to be propped to save them from breaking. The method recommended by Mr. Knight, however, is that of root pruning, which he thinks will accomplish the same result without disfiguring the tree.

Another method is to lay the roots bare for a time, and as soon as the tree flowers cover them with rich earth. With trees growing in warm, moist localities Woodrow advocates the application of salt at the end of the rainy season, about 10 pounds to the tree. This doubtless acts in the same manner, and if efficacious would seem a simple and economical method.

Under favorable conditions the mango is very prolific. The tree shown in Pl. II was estimated to have in the neighborhood of 5,000 fruits at the time the photograph was taken, and trees quite as prolific were seen near Cabo Rojo, P. R.; while trees in southern Florida before the freeze of 1886 were estimated to bear as high as 10,000 mangoes. From this it will be seen that with 25 to 100 trees per acre enormous quantities of mangoes can be produced on very small tracts of land, provided the right climatic conditions exist.

DISEASES.

The mango in Porto Rico seems almost entirely free from diseases or the attacks of insects. On the north side of the island the skin of the fruit is frequently disfigured by black spots, probably a fungus. Though in no way injuring the eating quality of the fruit these detract from its appearance and would doubtless lessen its market value. In the drier localities this discoloration was not observed, the fruit being uniformly smooth and clear. Should it be deemed advisable to take measures to prevent these spots, spraying with some fungicide would doubtless accomplish the desired result. With the introduction of better varieties, some of the diseases met with in other countries will possibly make their appearance. In Trinidad the better varieties are frequently affected by a disease that causes the pulp around the seed to darken and become sour and entirely inedible. It seems not improbable that the moist conditions prevalent in Trinidad may conduce to this disease, in which case the dry south side of Porto Rico will have an additional advantage.

In Porto Rico termites frequently build their nests in mango trees, but their galleries are constructed entirely on the outside of the bark, and do not appear to injure the tree in any way.

In introducing new varieties great care should be exercised not to introduce any of the almost innumerable parasites, both animal and vegetable, that prey upon the mango in other countries. All grafted stock and cuttings should be carefully inspected and disinfected before being planted.

USES.

The principal use of the mango is as a fresh fruit, and as such it deserves to become as common as the orange or the banana. A justification of this rather sweeping assertion is to be found in the degree of popularity which the mango enjoys in comparison with these better-known tropical fruits in countries where all are well established. Experience has shown that such comparisons are a better criterion of the ultimate popularity of an introduced fruit than the judgment of otherwise competent persons with whom the fruit is more or less of a novelty.

The intense flavor of some of the most fibrous mangoes is by many preferred to the milder and less fibrous varieties. The eating of the former is, however, such a difficult and untidy performance that the taste is much less frequently acquired than would be the case could some better method of conducting the operation be devised. Where the fruit is plentiful the method of peeling shown in Pl. VI enables one to secure the greater part of the flesh of a stringy mango without soiling the hands. A cut is made around either end of the fruit and these are then connected along one side, the central strip being peeled off in one piece. The skin remaining on the ends of the fruit affords a means of holding it without the fingers coming in contact with the juicy flesh. If in addition a sharp-pointed fork is at hand, this can be firmly fixed in the seed and the skin at the ends removed, thus saving the sweetest part of the fruit. Pl. VI, fig. 3, shows a special mango fork secured in Mexico by Dr. J. N. Rose. The long, slender tine in the center easily penetrates the seed and the shorter outer tines need only to touch the seed to prevent it from turning.

The mango has numerous important secondary uses, among which may be mentioned the following:

THE CANNING OF THE GREEN OR RIPE FRUIT.

Mr. E. M. Shelton,[a] of the department of agriculture, Queensland, gives the following recipe:

After peeling, the fruit is separated from the stones by slicing into pieces of convenient size; these should be stewed for a few minutes only, before pouring into cans, in sirup strong or weak in sugar to suit taste, or the fruit may be cooked in the can

[a] Bulletin of the Botanical Department of Jamaica, July, 1894, Vol. I, p. 111.

with sirup, as before. There may be a difference of opinion as to the palatableness of canned mangoes. A considerable number of those persons who have tasted the results of our work have pronounced the canned fruit excellent, while others have declared their indifference to it. A like diversity of opinion, we note, holds respecting the raw fruit, particularly to those unaccustomed to its peculiar flavor. Mangoes stewed in the form of sauce will be found a welcome addition to any dinner table. "As good as stewed peaches," we have heard them pronounced.

MARMALADE AND JELLY.

The same writer also gives the following directions for making the fruit into marmalade and jelly:

Marmalade.—Peel and slice the mango, cutting close to the stone, and cook, using plenty of water. Boil until the fruit is thoroughly disintegrated, when the pulp should be run through the colander with the purpose of extracting the "wool." Sugar should now be added to suit the taste (about three-fourths of a pound to the pint of pulp), and the mass boiled until clear, when it should be poured into the molds or jars in which it is to be kept. This marmalade is of a rich golden-yellow color; it retains the form of the mold perfectly, and seems in all respects to satisfy the most exacting taste. In the absence of the experience necessary to test the keeping qualities of mango marmalade, it would be the part of wisdom to seal the jars designed for future use while hot with wax, or better yet, with a plug of cotton wool.

Jelly.—For jelly, prepare the mangoes by slicing as for marmalade, boil the fruit with water, prolonging the boiling only to the extent of extracting the juices. Great care should be taken in boiling, as the mango rapidly "boils to pieces," in which case it is impossible to make satisfactory jelly. Pour off the juice, strain, and boil down to a jelly, an operation that occupies only a few moments, as the mango is rich in gelatinous materials; the pulp remaining after the jelly has been removed may be used to advantage in making marmalade. In the amount of sugar used in making jelly, the housekeeper is safe in following old practices in this respect with other fruits. It is impossible to give exact rules in all the operations connected with working up this fruit. In general, it will be well to use, in boiling, water somewhat to excess, and as the mango "cooks" readily, constant watchfulness is needed to prevent burning.

To show something of what is possible in the way of results with this fruit, I may say that in our experiments 13 good-sized mangoes gave 1 pint of jelly and 5 quarts of marmalade. This certainly must be counted a very favorable, not to say remarkable, result.

About Acapulco Dr. Edward Palmer found the foreign residents making the unripe mangoes into an excellent jelly, with the mango flavor so modified as to please even those who do not care for the fresh fruit. At the same place the experiment had been tried of making sweet pickles of the green fruit, with very satisfactory results.

During the height of the season in Porto Rico, mangoes can be bought at retail at the rate of 5 to 25 cents per hundred, at which price the cost of the fruit in making jellies and marmalades is nominal, and as the cheap sugar made in Porto Rico is suitable for making preserves, and the transportation charges on the finished product low, it would seem that if a salable article could be produced, its manufacture ought to be profitable. In view of the abundant supply and the

wonderful cheapness of the mango in Porto Rico, some of these uses will warrant investigation and experiment. Another consideration in this regard is the fact that the commoner sorts at present growing in Porto Rico are probably much better suited to the above uses than the milder-flavored varieties so highly prized for consumption in the fresh state.

A very delicious dish can be made by simply peeling mangoes when unripe but nearly full grown; slice, place in a dish, pile on sugar, and bake in a slow oven.

CHUTNEY.

The mango forms one of the chief ingredients of chutneys, concerning which the following, copied from Bulletin No. 46, Botanical Department, Jamaica, applies equally well to Porto Rico:

> Large quantities of chutney are imported into America from India, although it could readily be supplied from Jamaica, affording employment to a number of people, and utilizing much material which now goes to waste.
>
> The following recipe has been kindly forwarded by a correspondent: Three pounds common mangoes (turned, but not ripe); 3 pounds tamarinds; 2 pounds raisins (weighed after stoning); 8 pounds brown sugar; ½ pound chilies; 2 pounds green ginger; ½ pound garlic or 1½ pounds onions; ¼ ounce mace; 1 ounce mustard seed; ¼ ounce cloves; ¼ ounce pimento; ½ pound table salt. Soak the tamarinds in 2 quarts of the best vinegar, stir them about with a wooden spoon to get the pulp off, and take out the seeds and the leathery part in which they are inclosed. Cut the raisins small. Peel the ginger and grate it. Pound the chilies, garlic, and mustard seed in a mortar, using a little of the vinegar to moisten. Mix all together thoroughly; it is then ready for use.

ALCOHOL.

According to Mr. Dybowski,[a] the bruised and imperfect fruit that would otherwise be lost is sometimes utilized to produce by distillation a fair grade of alcohol.

MEDICINAL PROPERTIES.

While not possessing any pronounced and universally recognized medicinal properties, the mango is in India credited by the natives with a great variety of virtues, and numerous medical authorities speak very highly of certain of its uses.

As stated elsewhere, the fresh ripe fruit is considered slightly laxative and diuretic. The rind and fiber, as well as the unripe fruit, are astringent and acid. A long list of medicinal properties is given in Watt's Dictionary of the Economic Products of India, among which the most important and best authenticated are the following:

The unripe fruit, peeled, cut from the stone, and dried, is considered one of the best antiscorbutics, and is said to stamp out scurvy when lime juice and all other available remedies fail. Prepared in this way

[a] Traité Pratique de Cultures Tropicales, Paris, 1902, p. 534.

it is known as *amchúr* or *ambchúr*, and is an extensive article of diet in India.

The dried and powdered kernel of the seed is a valuable astringent, extensively used in cases of diarrhea and dysentery. One-half of a kernel taken in the morning and the same dose repeated in the evening are said to cure the most obstinate case inside of five days.

The unripe fruit roasted and made into a sherbet is taken by the natives of India to prevent sunstroke; the pulp is also rubbed over the body for the same purpose.

An extract of the bark or rind is highly recommended for its extraordinary action in cases of hemorrhage.

DYE, TAN, AND PIGMENT.

In some parts of India[a] the leaves of the mango are used to produce a yellow dye, as is also the bark, which is frequently mixed with that of other trees, among which are mentioned the pomegranate and a species of Bauhinia. With the bark of some trees it yields a permanent black. The juice of the bark mixed with lime is said to produce a fleeting green dye, while the addition of tumeric to the above mixture gives a bright rose-pink.

The dry, unripe fruit is extensively used as a mordant, especially in dyeing with safflower.

The bark and even the leaves are used as a tanning material, one sample of the bark yielding, on analysis, 16.7 per cent tannin.

Piuri, or Indian yellow, a coloring matter used in water colors and for painting houses in India, is indirectly the product of the mango. Before August, 1883, the source of this Indian coloring matter was unknown. At that time F. N. Mukhargi, at the request of Sir Joseph Hooker, made a trip to Monghyr, where the dye is produced, and found that it was obtained from the urine of cows fed on mango leaves. His letter is published in No. 39 of the Kew bulletins. Mr. Mukhargi states that the cows utilized for this purpose are kept exclusively on a diet of mango leaves and water, which increases the bile pigments and imparts to the urine a light-yellow color. The cows thus treated are made to pass urine three or four times a day by having the urinary organ rubbed, and soon lose the ability to urinate voluntarily. The urine is heated and the yellow precipitate is strained out and made into balls, dried on charcoal fires and in the sun, when it is ready for market. The price paid by the dealers is about 40 cents per pound. About 2 ounces a day is obtained from an average cow.

An exclusive diet of mango leaves is said to be injurious to the cows, and to keep up their strength the animals are now and then allowed grass or other fodder, which, however, reduces the proportion of the coloring matter.

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[a] Watt's Dictionary of the Economic Products of India, Vol. V, p. 152.

GUM.

The gum which exudes from the trunks of mango trees, frequently in considerable quantities, is said to be a substitute for gum arabic.

MINOR USES IN INDIA.

The multitude of uses the mango has in India, where it is not merely a luxury but an important food staple, have been summarized in Watt's Dictionary as follows:

When green, the stone is extracted, the fruit cut into halves or slices, and (*a*) put into curries; (*b*) made into a pickle, with salt, mustard oil, chilies, and other ingredients; (*c*) made into preserves and jellies by being boiled and cooked in sirup; (*d*) boiled, strained, and with milk and sugar made into a custard known as mango-fool; (*e*) dried and made into the native "ambchur," used for adding acidity to certain curries; (*f*) when very young cut into small pieces, mixed with a little salt, and sliced chilies and milk added, it forms a "tasty" salad.

When ripe (*a*) it is made into curry which has a sweet, acid, not unpleasant, taste; (*b*) it is cut into small pieces and made into a salad with vinegar and chilies (the sour fruit is sometimes so used); (*c*) the juice is squeezed, spread on plates, and allowed to dry; this forms the thin cakes known as amb-sath. The kernels are eaten in times of famine, and by the poorer classes in many parts of India they are boiled and eaten as greens. They are also ground with meal and mixed with various other ingredients to form the relish known as am-khatai. When stuffed with coriander, turmeric, and other spices, and boiled in mustard oil, they are esteemed a great delicacy.

THE MANGO IN PORTO RICO.

PRESENT STATUS.

The mango is one of the most common fruits in Porto Rico, and during the season when this fruit is ripe it is eaten in larger quantities than any other, with the possible exception of the banana, which latter is used more as a vegetable, cooked in one form or other. That it is a popular as well as common fruit is shown by the fact that when mangoes are scarce people are willing to pay comparatively high prices for them, and this in spite of their being looked upon as luxuries rather than as staple articles of food.

Porto Rico seems very well adapted to the production of mangoes and, as the plant is strictly tropical and very susceptible to cold, would seem to have a decided advantage over Florida, where good varieties are already successfully grown, but where, except in the extreme southern part, the danger of injury from cold is very great. A really high-grade mango is unknown in Porto Rico, and the first steps toward making their exportation profitable is the introduction from the other islands, or from Florida, Mexico, or the East Indies, of grafted stock of the best varieties. Even seedlings of improved forms would without doubt be a great advance, but until the quality is in some way improved the shipping of mangoes in other than small lots will scarcely prove profitable, as the sale of the mango in its present

form will be largely limited to those who have at some time lived in a country where the fruit is grown and have already acquired a liking for it. With this class even poor mangoes will always find a market, if good ones are not to be had.

That mangoes of the best varieties can be grown in America has been demonstrated, although only small quantities are as yet produced. Mr. D. G. Fairchild, who has had excellent opportunities to test mangoes in all parts of the world, says that with the possible exception of the Bombay Alphonse the finest mango he ever tasted was one of the variety known as "Mulgoba" and grown in Florida.

The mango grows in all parts of Porto Rico, but is more common on the drier south side of the island, where the trees will occasionally be seen growing so thick as to suggest an orchard. (See Pl. I.) It can scarcely be said to be cultivated at all, as few trees are planted and most of the fruit is obtained from trees that have spread spontaneously. It seems to prefer dry hill slopes, and was seen in the greatest profusion about Cabo Rojo. Trees are seldom seen growing about houses. This may, however, be due to a superstition that the shade of the mango is dangerous, our Porto Rican driver on one occasion preferring to have his horses stand in the hot sun rather than in the shade of the deadly mango.

If the tree is propagated artificially at all, it is by means of seeds. The only indication that any grafted stock exists in Porto Rico was a statement heard in Yauco to the effect that the variety known as Melocoton is from grafted stock brought from Martinique. The importation may have been made, but even if such is the case it has been of little value, as it has since been propagated only through seedlings.

The season of ripe mangoes in Porto Rico is from May to August. By selecting proper varieties this might be prolonged, since in some parts of India it extends over a period of six months. This would be a great advantage in shipping the fruit to temperate regions, as at present the season coincides with the season of temperate fruits, which places the mango at a decided disadvantage.

BEST LOCALITIES.

Mango plantations in Porto Rico, to be most profitable, should without doubt be located in the drier parts of the island, where, as has been said, the trees are not only more prolific, but the fruit is better formed and more free from blemishes. The whole south side, a narrow strip across the western end, and the northwest corner would seem to be well adapted. The southwestern part of the island is at present producing the best mangoes. In this region there are many more or less extensive tracts of low-priced land unsuited to the growing of other crops, but apparently adapted to the mango.

Mango trees are common about San Juan, but this region is so moist that the trees are not prolific and the fruit is frequently deformed and spotted.

PORTO RICAN FORMS.

There are a great many forms of the mango in Porto Rico, but at present their classification is little more than a list of names. The same name is applied in different parts of the island to distinct fruits, and, again, what appears to be the same form will receive distinct names in different localities. In any given market, however, considerable agreement will be found as to the terminology of forms, though the fruit is evidently picked in bulk and sorted before being offered for sale. In some markets this is carried much farther than in others. The fruit of the same tree seems always to be very nearly uniform, but as the mango comes true to seed only to a limited extent and the fruit in Porto Rico is all from seedlings, an almost endless variety is naturally to be expected.

True varieties—that is, varieties propagated by asexual methods—do not exist in Porto Rico, and the following descriptions are intended to assist in fixing the vague terminology of the market forms and if possible to stimulate further observation as to whether these come true to seed. These forms should not be confused either with true horticultural varieties or, until further investigation, with races that are known to come true to seed.

The forms described below are those that fell under immediate notice, the name most commonly in use being appended.

Mango de Mayaguez (Pl. VII).—A small yellow form, with comparatively large seed, but with good flavor, soft flesh, and few fibers. This form, for sale in the San Juan markets, is considered one of the finest. It has very little of the turpentine taste, but its flavor did not appear to be any better than that of several others, while its small size and thin flesh make it seem on the whole inferior. In shape it is asymmetrical, with depressed stem. The color in the early part of the season is a uniform yellow; later many specimens were seen with one side red.

Mangotina (Pl. VIII, fig. 4).—A very small yellow form, with one side red. Similar to the Mango de Mayaguez seen at San Juan but longer, with rounder base and the stigmatic point nearer the apex.

Melocoton "peach" mango (Pl. VIII, fig. 1).—A small yellow and red form seen at Yauco, said to have come from grafted stock brought from Martinique. Base very square, stem slightly depressed, skin thin, meat with very few fibers, mild in flavor.

Mango de rosa (Pl. VIII, fig. 2).—A nearly spherical form seen at Yauco, yellow in color, with one side a beautiful red. The skin is very thin, the meat comparatively free from fiber, very mild and pleasant, without a trace of the turpentine flavor.

Mango piña (Pl. IX).—A short, thick form found in the San Juan market before the middle of June, green, slightly asymmetrical, with rather oblique base, stem depressed. The meat is thick, of good texture and flavor.

Mango largo (Pls. VIII and X).—A form common on the south side of the island and at Mayaguez. Long, nearly straight, stem not depressed, green in color. The flesh is very firm, moderately thick, and with very few fibers. At Yauco slightly shorter specimens were called "Mangotina," a name used very loosely in all markets, this form selling there at 10 for 1 cent. The flavor is fine, though the taste of turpentine is pronounced, and to those who do not object to this feature it will appeal as one of the best Porto Rican forms.

Mango mangó (Pl. XI.)—A large, rather straight form, with a very square base, somewhat resembling "largo," but slightly more symmetrical and thicker. Large quantities were seen in the San Juan market on June 22; a month later none were to be found. The flesh was fairly thick and of good quality.

This name may possibly be a contraction of *mangon*, which would be not at all inapplicable, as this is one of the largest Porto Rican forms. Stahl gives *mangó* as the common name of *Mangifera indica* in Porto Rico.

Mango jobos (Pl. XII).—A common form in the San Juan market in the early part of the season. A very poor kind, considered to be the wild or unimproved form. It is green in color, with a large seed and very stringy meat, frequently ripening unevenly and having a strong turpentine flavor. In form it is slightly asymmetrical, stem not depressed.

Mango redondo (Pl. XIII and Pl. IV, fig. 2).—A large, thick-meated form, common in the Ponce market. In form it is quite symmetrical, with a decidedly depressed stem. In color it varies from green to red, the difference being in some instances so marked as to suggest a distinct type. The color seemed the only difference, however, and the market people insisted that the green and red might come from the same tree. The flesh is very juicy, moderately free from fibers, and of a very good flavor.

VARIETIES TO BE INTRODUCED.

There are probably hundreds of excellent varieties and forms grown in India and elsewhere that might profitably be introduced into this country, but it would perhaps be better to introduce a very few of the best sorts and get them thoroughly established than to dissipate energy on a great number.

As early as 1869 some seventeen varieties of Indian mangoes were successfully introduced into Jamaica. These have since been propagated and new importations made until there exists in Jamaica a con-

siderable number of Indian mangoes. The best varieties are, however, confined to gardens, and very few of the choicer kinds are exported. There are also a few Indian varieties in Trinidad and Florida.

Among the varieties of mangoes that should be introduced into Porto Rico, the following may be mentioned:

Mulgoba.—"Form roundish, oblique, reniform; size large, weighing from three-fourths pound to 1 pound; surface smooth and undulating; color yellow, beautifully blushed with red and faintly dotted with numerous brown dots; skin thin, tough, tenacious; seed reniform, oval, rather large; fiber scanty, fine, and tender; flesh rich, apricot yellow, very tender, melting and juicy, sweet, rich, fragrant; quality very good.

"The Mulgoba surpasses in flavor and quality the seedlings previously grown, but its most distinctly marked features of superiority are the tenderness of the flesh and absence of the objectionable fiber and strong turpentine flavor common to most of the seedlings grown in this country.

"The tree is a strong, symmetrical grower, and appears to be abundantly productive."[a]

Grafted stock of this variety was secured by the Division of Pomology, U. S. Department of Agriculture, in 1889 and placed with fruit growers in southern Florida. After a narrow escape from the freeze of 1895 the surviving tree has done well, and the variety has been successfully propagated. This variety should be at once introduced into Porto Rico.

Alphonse, Aphoos, or *Alfoos*, is perhaps the most noted of mangoes. Woodrow says:

> It is universally admitted to be the finest of all mangoes. In flavor its fruit is indescribable; it seems to be a subtle blending of all agreeable flavors. In weight the fruit averages 8 ounces, and in color green, enriched by a crimson glow on the exposed side, and in shape oblong, slightly thickened at the upper end, and without any prominent stigmatic point or beak.
>
> The leaves vary much in size and shape, and with difficulty can be distinguished from common varieties; but among the choice varieties the leaves of the Alphonse may be known by the bright red midrib apparent until the leaves are nearly ripe. The branches of the inflorescence are of a rich rosy color.
>
> In manner of growth or habit this variety is rather stunted and irregular, rarely forming a graceful tree. It is also very delicate and apt to give way before insect attacks more than other varieties; but as its fruit is valuable it should be kept free from insects and otherwise protected in proportion to the price the fruit brings.[b]

This is a very early variety and so highly prized in India that as much as $19 a hundred is sometimes paid by dealers for selected fruit.

In June, 1902, several inarched plants of this variety, all from a single tree known to produce superior fruit, were sent from Bombay by

[a] W. A. Taylor, Yearbook, U. S. Dept. of Agr., 1901, p. 390.

[b] Gardening in India, pp. 226, 227.

Mr. D. G. Fairchild, Agricultural Explorer of the U. S. Department of Agriculture. Some of these were sent out at once through the Division of Pomology to experienced growers in Florida, where they were budded on healthy stock and are now doing well. Budding was also successfully accomplished from the remaining plants held in the greenhouses at Washington, and the variety seems now safely established.

A letter from Col. J. G. E. Griffith,[a] Hodges, Black River, Jamaica, states that after three attempts he imported in 1901 six Alphonse and six Paeree plants, eight of which are now doing well. Five of these are believed to be Alphonse.

Every effort should be made to preserve this valuable variety, and budded or inarched stock should be introduced into Porto Rico as soon as possible.

It might also be desirable to secure one or two of the late fruiting forms. Several varieties, grouped in Watt's Dictionary under the name of Budayas, are said to fruit as late as September or October, whereas the Alphonse fruits in May.

No. 11.—This variety, the original stock of which was among the first mangoes introduced into Jamaica by Captain Marshall, in 1782, is still the most popular variety in the island. It is a fine fruit, though somewhat stringy, and is said to come true to seed. Mr. Hart identifies this variety with the Reine Amelie of Martinique. As Martinique received a large part of its early introduced plants from Mauritius, the source of this variety in Jamaica, this identification doubtless means identity of origin, and the fact that these distinct strains are still identifiable would argue great constancy for this variety. Budded stock of this variety is also growing in Florida.

Manila (Pl. XIV).—A Mexican race, almost entirely free from fiber, and of a mild, pleasant flavor. The skin is uniformly light yellow and thin; the flesh is also light colored and firm. The seed is very thin and small in proportion to the amount of flesh.

This is a really high-grade mango, not unlike the Mulgoba in flavor. Its shipping qualities have not been tested, but perfectly ripe fruit purchased in Mexican markets kept in good condition for several days. This mango was very popular in the City of Mexico about the end of June. It was sold in all the markets and hawked on the streets, the price being usually 4 cents apiece Mexican. The uniformity of the fruit as it appeared in the different markets, taken with the absence of asexual methods of propagation in Mexico, would argue that it is a form that comes true to seed. If this is the case, it would certainly be one of the most desirable mangoes for Porto Rico, and seed should be secured at an early date.

The name of this race suggests that it came from the Philippine

[a] Bul. Bot. Dept. Jamaica, Vol. VIII, pts. 11 and 12.

Islands, and indeed it is not impossible that it was brought to Mexico from those islands by one of the Spanish galleons that during the seventeenth century plied regularly between the Philippines and Mexico.

A form resembling this in Guam is there commonly supposed to have come from the Philippines, but as ships only touched at Guam on the return voyage from Mexico the fruit must have reached Guam by way of America, and would naturally have become established in both countries. Possibly a further confirmation is to be found in the occurrence of the same or a very similar form in Cuba, known as the Philippine mango.

Mango china.—A very fine seedling race, common in the markets of Guatemala City, and considered the finest mango of that region. The form of the fruit is characteristic, being very thin and almost circular in outline, with a prominent blunt "nak," located some distance from the apex. The flesh is thick and remarkably free from fiber for a seedling, mild and aromatic, without suggesting turpentine.

This variety differs from others examined in having pronounced longitudinal ridges on the seed, which is thin and very broad. (See Pl. V, fig. 1.) Like the Manila of Mexico, this form apparently comes true to seed. It could easily be secured and would certainly be an improvement on anything at present in the island. By some this form is called *Mango de brea.* This name is, however, more appropriately applied to another form in which the fruit is more or less coated with a pitch-like exudation, *brea* meaning pitch.

There are a number of excellent varieties and forms already growing in other islands of the West Indies, which it might be desirable to introduce. The fact, however, that Indian fruit is outselling the West Indian in the London market would indicate that the best Indian varieties should receive the most attention. It is possible that the best kinds are not exported from the British West Indies where mangoes as good as Indian varieties may be growing, but where under the unfavorable conditions they do not bear sufficient fruit to permit of being exported. These same mangoes, if transplanted to the south side of Porto Rico, might become much more prolific, and on account of the ease with which they could be introduced the subject should receive careful attention.

In Bulletin No. 20 of the Botanical Department of Trinidad, July, 1889, Mr. J. H. Hart describes the Trinidad varieties, some of which would appear to be very excellent. Among the most desirable kinds may be mentioned the following:

Gordon.—A fine large fruit. The seedlings are said to produce fruit almost identical with those of the grafted stock, and are thought to bear better.

Peters.—One of the finest flavored of all Trinidad mangoes, said to bear regular crops. In Trinidad this variety is very subject to souring in the center of the fruit. This would probably be much less troublesome in Porto Rico.

Julie.—A fine, large mango, with thin, long seed; commences to bear when very young.

On the west coast of Africa and in some other localities the mango has two seasons of bearing ripe fruit, about six months apart. At Esquintla, Guatemala, where the mango grows luxuriantly and is very prolific, this appears to be the case, as many trees were seen bearing flowers and nearly ripe fruit at the same time, April 16. If this is a difference in kind and not due to climatic conditions these forms should be imported, as the placing of a new fruit on the market would be greatly facilitated could it be done in the winter, when competition with native fruits would be less.

BEST METHOD OF INTRODUCING NEW VARIETIES.

The introduction of new varieties from the East Indies has been attended with much difficulty. Seeds can, of course, be secured at comparatively small expense, but in most of the cases on record only a small percentage have germinated, and these, after the trouble and delay of bringing them to bearing, are likely to produce fruit with only a slight resemblance to the variety desired.

Hitherto the most successful importations have been in the form of inarched stock in Wardian cases. This, though a very satisfactory method, is very expensive, and a less costly plan would greatly encourage importations.

Experiments in packing cuttings, suitable for budding, so that they may be sent through the mails, have been made by Mr. D. G. Fairchild. He recommends the following method:

> Have a cylindrical tin case made, 10 inches long, 2 inches in diameter, with a well-fitting cap 2 inches long, in which to send the cuttings through the post. This case should be fitted in a cloth sack before dispatching. Cut scions about 10 inches long, making sure that they have good buds on them. Dip the cut ends in collodion or melted beeswax, wrap each scion in a strip of light tin foil, and wrap these again in oiled paper. Pack not more than four or five in each case, with slightly moistened sawdust. Be careful to put the address on the tag.

The first shipment of mango cuttings packed in this manner arrived in rather poor condition, the sawdust in which they were packed being apparently too moist. Buds, which were immediately placed in the healthy stock, showed signs of life, but it is still too early to report the success or failure of the experiment. The sending of a second shipment, packed in drier sawdust, was so delayed that the severe heat encountered on the voyage resulted in an entire loss. Experiments

with this method of packing are being continued by Messrs. Taylor and Fairchild, as the system has not as yet received a fair trial.

Experiments made by Mr. H. Knight, in Queensland, on the keeping quality of mango cuttings proved that cuttings carefully packed in cocoanut fiber would remain alive and in good condition for at least three and one-half months. Cuttings were tried in both moist sand and cocoanut fiber that had been boiled, washed, and squeezed dry. The cuttings were packed in tight tins. At the end of two months, of 14 cuttings packed in moist sand, all were dead but one, while after three and one-half months all the cuttings in the cocoanut fiber were alive and had shoots from 2 to 4 inches long. This length of time is ample for the introduction of new varieties from India to this country, but the cuttings thus experimented with were doubtless kept at a reasonably uniform temperature, and it must not be inferred that they would have survived a voyage to the West Indies where, owing to the changes to which they would be subjected, they would probably have deteriorated much more rapidly. The fact that the cuttings made sprouts, while indicating the success of this method of preserving the life of the cuttings, would not be desirable if the cuttings were to be used for budding. This could, however, doubtless be prevented by drier packing.

The introduction of new varieties by means of cuttings that can be sent through the mails would be such a simple and economical method that it is well worthy of experiment, but in view of the difficulties which many have experienced in budding the mangoes it may be well not to place too much dependence on this method until budding has been successfully accomplished from cuttings thus treated.

The propagation and dissemination of the finer varieties of the mango might well be one of the lines of activity of the experiment stations recently established in the tropical possessions of the United States.

PACKING AND SHIPPING.

The packing and shipping of mangoes is a question of great importance, as the success or failure of their production on a commercial scale is to a large extent dependent on its proper solution. With the poorer varieties, it is a comparatively simple matter, and the fruit wrapped in paper and packed in cases comes through in very good shape. With the finer varieties the question is, however, much more difficult. Sample lots of the best varieties grown in the West Indies have been shipped long distances, as from Jamaica to London, and have arrived in good condition.

In larger lots it would doubtless be much more difficult, but with proper care it would seem that the loss need not be serious. The

advisability of shipping in cold storage has never been properly tested, but the general opinion seems to be that low temperatures injure the flavor of the fruit. Mr. J. H. Hart, Superintendent of the Royal Botanical Gardens of Trinidad, recommends[a] a temperature some 8° or 10° below that in which the fruit was ripened. "Pick the fruit," he says, "when fully formed or 'full,' handle without bruising, or, as I wrote many years ago of oranges, 'handle as you would eggs,' choose well-formed and uninjured fruit, pack so that fruit receives no undue weight or pressure, place for transit in a well-ventilated part of the ship, and nearly every kind of fruit can be carried successfully for voyages of from six to fourteen days or more, mangoes of the best kind among the number;" while experiments in shipping mangoes from Australia would indicate that a temperature of about 35° was the most satisfactory.

There can be no doubt that questions of ventilation and of packing so that the fruit is not subjected to undue pressure are of more importance than the exact temperature, and the instructions of Mr. Hart will, if followed, allow good fruit to reach the northern markets in prime condition.

The United States consul at Bombay, William Thomas Fee, in his report for October, 1901, states that in the large shipments of mangoes now being sent from India to London the fruit is packed in the cast-off boxes used for shipping oil to India, and that it arrives in good condition.

M. Nollet, director of the garden at Martinique, has succeeded in making small shipments from that island to Paris with a loss not exceeding 10 per cent. The fruit was wrapped in soft paper and packed one dozen in a box, the interstices filled with sawdust and the whole placed in cold storage.

The fruit is usually picked when of full size, but before it has completely ripened, and is placed in shade to complete the process. In some parts of India it is buried in the ground to ripen, as this is supposed to make it sweeter.

To establish a market for Porto Rican mangoes, it will be necessary for some individual or company to undertake to grade, pack, and ship the fruit on a scale sufficiently large to enable commission merchants to receive regular consignments and feel confidence in the uniform quality and condition of the shipments. Growers may hesitate to embark in the production of mangoes on a large scale before a market is assured, but a market will not be assured until the supply can meet the above conditions. A large and well-organized plantation could probably best meet these requirements, but, in the absence of such, the neighboring planters of mangoes might very advantageously cooperate

[a] Bul. Royal Bot. Gardens, Trinidad, 1897–99, Vol. III, p. 192.

by combining their crops and placing the grading, packing, and shipping of the fruit in the hands of one person. The industry might thus be successfully launched without serious risk to individual planters.

MARKET.

Although a local market already exists in Porto Rico, the only outlook for making the growing of mangoes profitable is in a trade with the temperate regions. Such a trade can hardly be said to exist in this country, for, although small lots are frequently sent North and are disposed of at from 5 to 10 cents apiece, they have been sold merely as novelties; for the few larger shipments that have been made there was no sufficient demand, and to avoid total loss prices had to be lowered so that Porto Rican mangoes have been sold in Washington at the rate of 2 for 5 cents.

What can be done with mangoes of the best quality in this country is still a matter of conjecture; but in view of the unanimously favorable opinion of those who have tasted good varieties, it would seem that it is merely a question of being able to produce good fruit and to ship it in good condition.

The history of the mango in Florida affords some very encouraging data regarding profits to be derived from mango culture. The following, quoted from Bulletin No. 1, Division of Pomology, U. S. Department of Agriculture, refers to trees growing in the neighborhood of Tampa Bay:

> One grower on the point sold, from eleven trees in the fourth year from the seed, fruit which brought him $219. In their sixth year he shipped bushels to various places, realizing at Chicago 60 cents per dozen, and the fruit shipping well. Another dealer received from the produce of one of his bearing trees $66 in its sixth year.

These mangoes were probably of inferior varieties, as Mr. William A. Taylor states[a] that prior to 1889 none but seedling mango trees were grown in Florida. On the other hand, the quantities were so small that the fruit was probably sold as a novelty and the profits realized give little idea of how larger and continued shipments would fare.

In England the trade is much farther advanced. There has been a small trade between Jamaica and England for a number of years. The following, copied from the Bulletin of the Botanical Department of Jamaica, No. 39, January, 1893, page 23, is a statement of the number and value of mangoes exported during the years 1887 to 1892, to which is added the approximate price per 100.

[a] Yearbook, U. S. Dept. of Agriculture, 1901, p. 390.

Number and value of mangoes exported from Jamaica, 1887 to 1892.

Year exported.	Number.	Value.			Approximate value per 100.
		£.	s.	d.	
1892	258,060	203	2	6	$0.38
1891	222,020	158	12	6	.35
1890 (one-half year)	18,388	19	19	0	.53
1889	170,988	100	19	6	.29
1888	299,584	258	9	0	.42
1887	93,470	116	6	0	.60

The following statement is also made:

This export will never be of any great value unless the fruit is picked by hand and packed with care, for the least bruise is fatal. Good mangoes would doubtless fetch a good price in New York.

Large shipments of fine East Indian mangoes are now being received in London and not only arrive in good condition, but are bringing fancy prices, quite outselling the West Indian fruit, to which they are much superior.

This is decidedly encouraging, for if there is a demand for good mangoes in England, why not in the United States? And if it is possible to successfully ship fine varieties from India to London, there ought surely to be no difficulty in shipping from Porto Rico to New York.

SUMMARY.

The essentials for making the cultivation of mangoes in Porto Rico a profitable industry may be summarized as follows:

(1) The introduction and propagation of good varieties, meaning (*a*) fair-sized fruit, moderately free from fiber and with little of the turpentine flavor; (*b*) fruit that will stand shipping; (*c*) early and late fruiting varieties, and if possible varieties bearing two crops a year.

(2) Care in picking, packing, and shipping, that the fruit may reach the market in good condition.

(3) A general supervision of the shipping by some responsible person or firm, insuring uniformity and regularity of supply.

(4) The placing of good fruit before the public in such quantities that the price need not be excessive, and that the supply can be regular and continuous during the fruiting season.

If these conditions can be met, an increasing demand may be expected, and there seems no reason why the commercial production of mangoes should not be added to the agricultural industries of Porto Rico.

PLATES.

DESCRIPTION OF PLATES.

PLATE I. Grove of mango trees between Cabo Rojo and Joyua, Porto Rico. These trees were injured by the hurricane of 1899, and have not regained their typical form.

II. Mango tree in fruit, Tapachula, Mexico; estimated to be bearing about 5,000 mangoes.

III. Branch of mango tree, with fruit, Tapachula, Mexico.

IV. Fig. 1.—Mango tree, growing in dry region near San José, Guatemala. Fig. 2.—Section of "Redondo" mango fruit, Ponce, Porto Rico. (Natural size.)

V. Mango seeds: Fig. 1.—"Cocha." Fig. 2.—"Largo." Fig. 3.—"China." Guatemala City, Guatemala. (Natural size.)

VI. Fig. 1.—Mango fruit, showing method of peeling. (Natural size.) Fig. 2.—Crate of mangoes shipped from Florida to Washington, D. C., showing a successful method of packing. (Photograph loaned by W. A. Taylor.) Fig. 3.—Mango fork. (Natural size.)

VII. "Mango de Mayaguez" fruit, San Juan, Porto Rico. (Natural size.)

VIII. Mango fruits: Fig. 1.—"Melocoton." Fig. 2.—"Rosa." Fig. 3.—"Largo." Fig. 4.—"Mangotina." Yauco, Porto Rico. (Natural size.)

IX. "Mango piña" fruit. San Juan, Porto Rico. (Natural size.)

X. "Mango largo" fruit, Ponce, Porto Rico. (Natural size.)

XI. "Mango mangó" fruit, San Juan, Porto Rico. (Natural size.)

XII. "Mango jobos" fruit, San Juan, Porto Rico. (Natural size.)

XIII. "Mango redondo" fruit, Ponce, Porto Rico. (Natural size.)

XIV. "Manila" mango fruit, City of Mexico. (Natural size.)

XV. "Mango china" fruit, Guatemala City, Guatemala. (Natural size.)

GROVE OF MANGO TREES, BETWEEN CABO ROJO AND JOYUA, P. R.

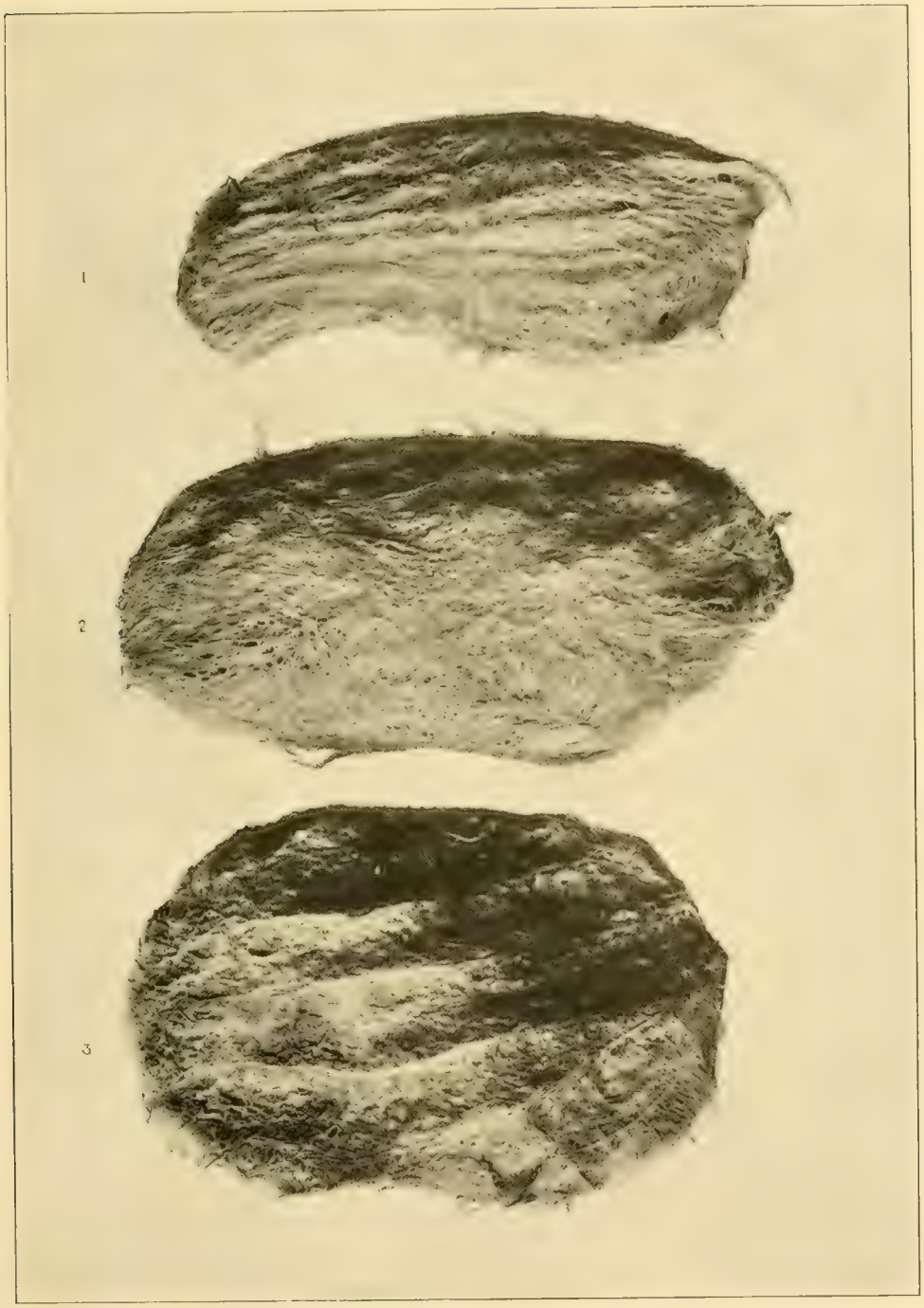
MANGO TREE IN FRUIT, TAPACHULA, MEXICO.

BRANCH OF MANGO TREE WITH FRUIT, TAPACHULA, MEXICO.

Bul. 29, Bureau of Plant Industry, U. S. Dept. of Agriculture.

FIG. 1.—MANGO TREE GROWING IN DRY REGION NEAR SAN JOSE, GUATEMALA.

FIG. 2.—SECTION OF "REDONDO" MANGO FRUIT, PONCE, P. R. (NATURAL SIZE).



MANGO SEEDS, GUATEMALA CITY (NATURAL SIZE).

1, "Cocha;" 2, "Largo;" 3, "China."

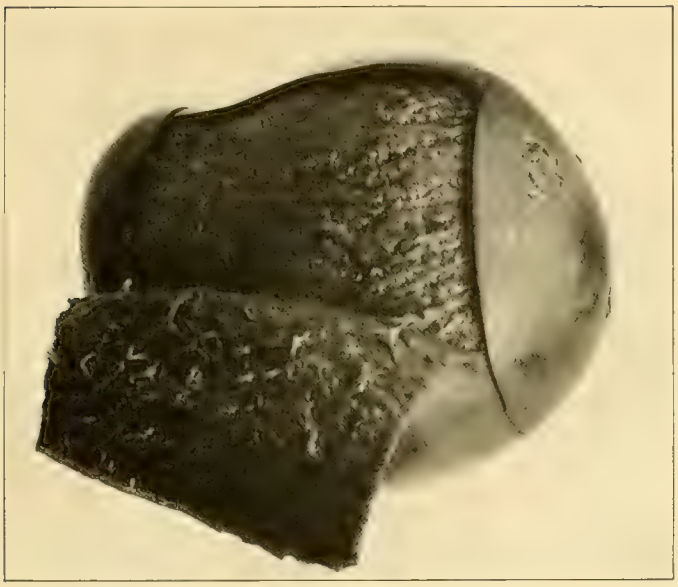


FIG. 1.—MANGO FRUIT, SHOWING METHOD OF PEELING (NATURAL SIZE).

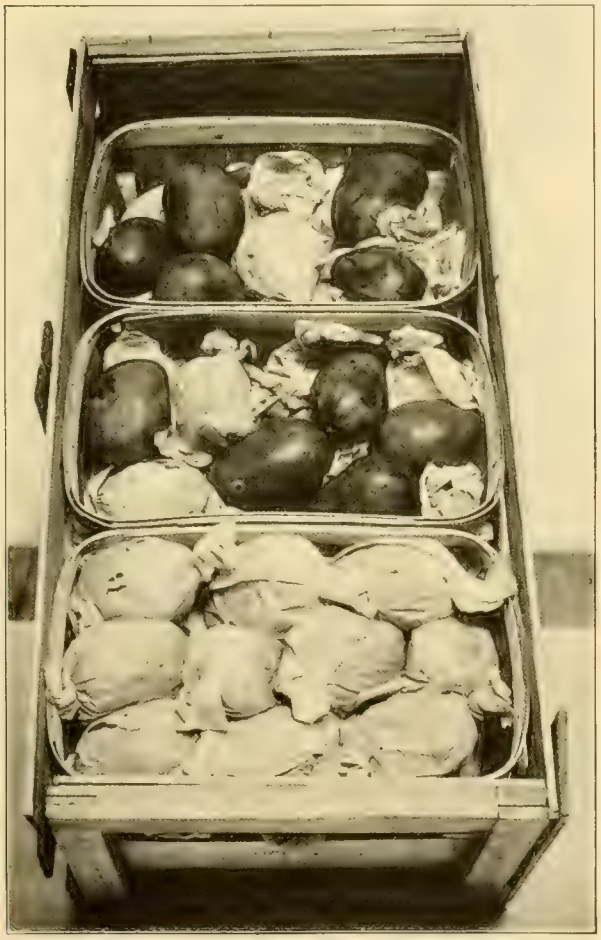


FIG. 2.—MANGO FRUIT, SHOWING METHOD OF PACKING.

FIG. 3.—MANGO FORK (FULL SIZE)

"MAYAGUEZ" MANGO FRUIT, SAN JUAN, P. R. (NATURAL SIZE).

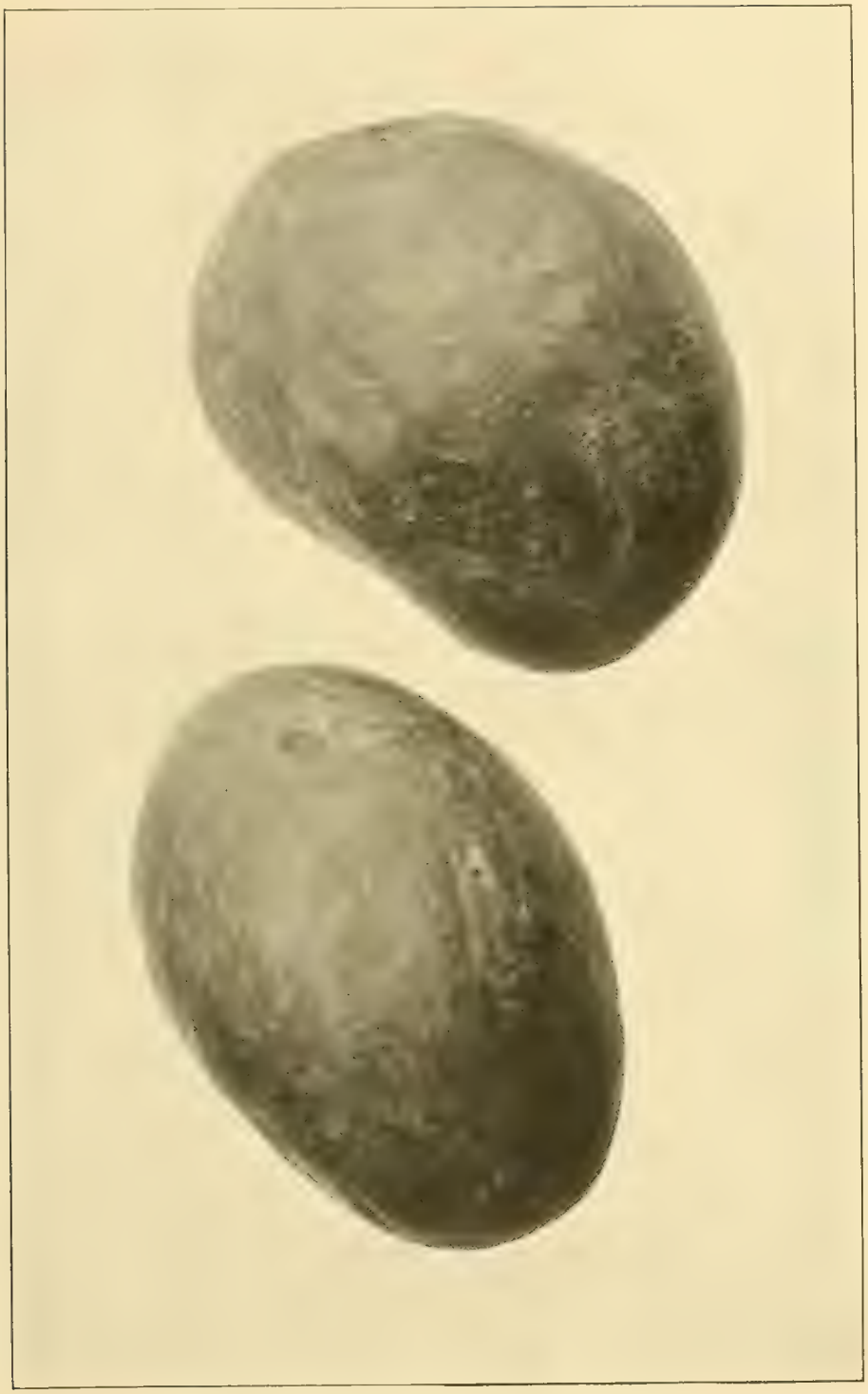
FIG. 1.—"MELOCOTON."

FIG. 2.—"ROSA."

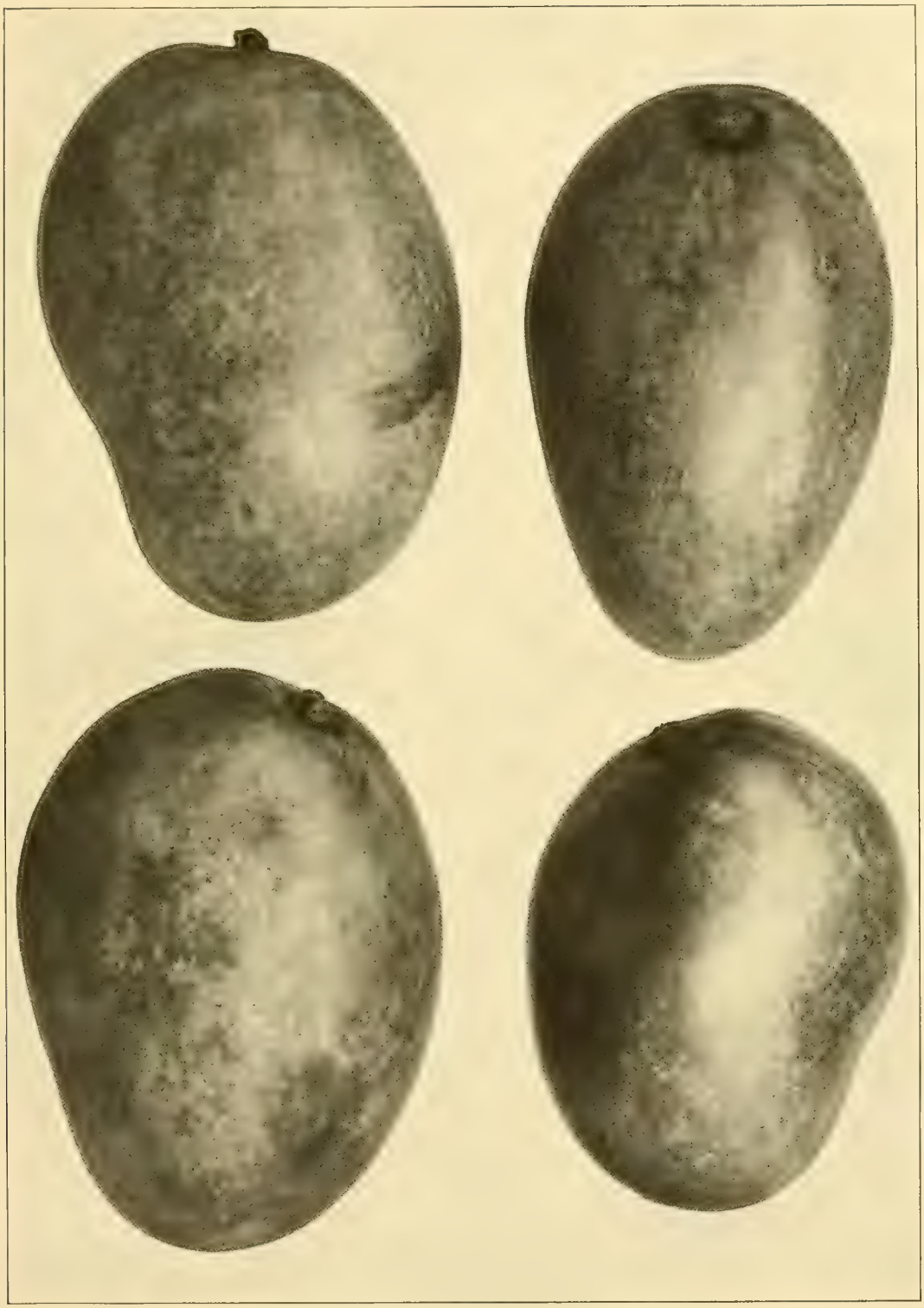
FIG. 3.—"LARGO."

FIG. 4.—"MANGOTINA."

MANGO FRUITS, PORTO RICO (NATURAL SIZE).



"PIÑA" MANGO FRUITS, SAN JUAN, P. R. (NATURAL SIZE).



"LARGO" MANGO FRUITS, PONCE, P. R. (NATURAL SIZE).

"MANGÓ" MANGO FRUITS, SAN JUAN, P. R. (NATURAL SIZE).

"JOBOS" MANGO FRUITS, SAN JUAN, P. R.

"REDONDO" MANGO FRUITS, PONCE, P. R. (NATURAL SIZE).

"MANILA" MANGO FRUITS, CITY OF MEXICO (NATURAL SIZE).

"CHINA" MANGO FRUITS GUATEMALA CITY (NATURAL SIZE).

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